



# **GEMSTONES**

# **HABITAT OF OPAL**

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**By**

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A photograph of a mountainous landscape. In the foreground, a deer with antlers stands on a grassy slope. In the background, other animals, possibly elk or moose, are visible on a similar slope. The text is overlaid on the image.

# Similar to Hunting Wild Game

## *Knowledge*

of

## Mineral Species & Habitat

## Important

**Common opal** – Abundant in Parts of Wyoming

**Precious opal** – Rare Everywhere ( $\leq 1\%$  in Aust.)

# Opal = October's Birthstone

**Earliest Known Use** ~ 4000 BC: Artifacts in Kenya

‘**Opal**’ - Ancient Sanskrit or Indian word ‘**upala**’,  
meaning ‘**precious stone**’ (Sinkankas, 1959)

**Imported to Rome** ~ 100 BC, probably from volcanic-hosted deposits in Hungary; Romans **believed** the source to be India (‘Oriental’).

***(Early Marketing)***

**Cortez:** Early 1500s, Honduras opals to Europe sold as ‘Hungarian’ due to European cultural bias

**Australian black opals:** Marketing before acceptance

# OPAL

AGGREGATE of HYDRATED SILICA



**Cryptocrystalline to Amorphous**

(extremely small crystals)      (not crystalline)

**Precipitate from Si-rich Aqueous Solutions  
within Vugs, Fractures, & Pores**

***Mostly* in Volcanic or Sedimentary Rocks  
May Replace Organic Material**



# OPAL DETAILS

**H = 5.5 to 6.5 Mohs**

**SPG = 1.9 to 2.25 Based on Porosity & Impurities**

**Fracture = Conchoidal**

**H<sub>2</sub>O Content = 2% to 20% (weight)**

**H<sub>2</sub>O Loosely Bound within Structure: Driven off by Dryness or Heat → may cause Crazing (cracks)**

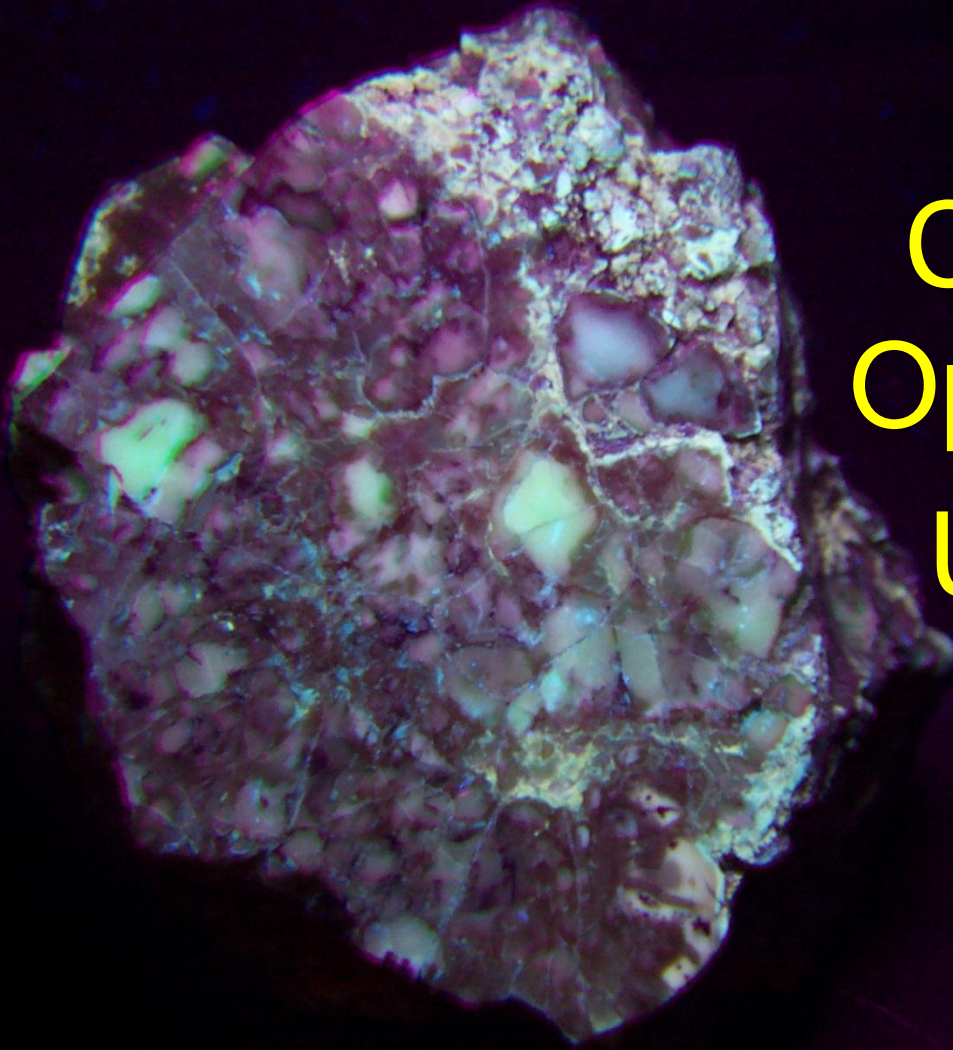
**Or turn opal opaque & white**

**More H<sub>2</sub>O → Greater Translucency & Crazing**

**Less H<sub>2</sub>O → Increased Opacity & Less Crazing**

**Luster = Vitreous to Resinous, or Pearly**

# Fluorescence Not Distinctive (Some Opals Fluoresce, Many Do Not)



Cedar Rim  
Opal Breccia  
Under UV  
Light

# Opal may grade into Chalcedony

Sweetwater Moss Agate

Associated With Opal at Cedar Rim



Chalcedony

(Agate)

SPG =

2.58 to 2.64



# Sweetwater Moss Opal

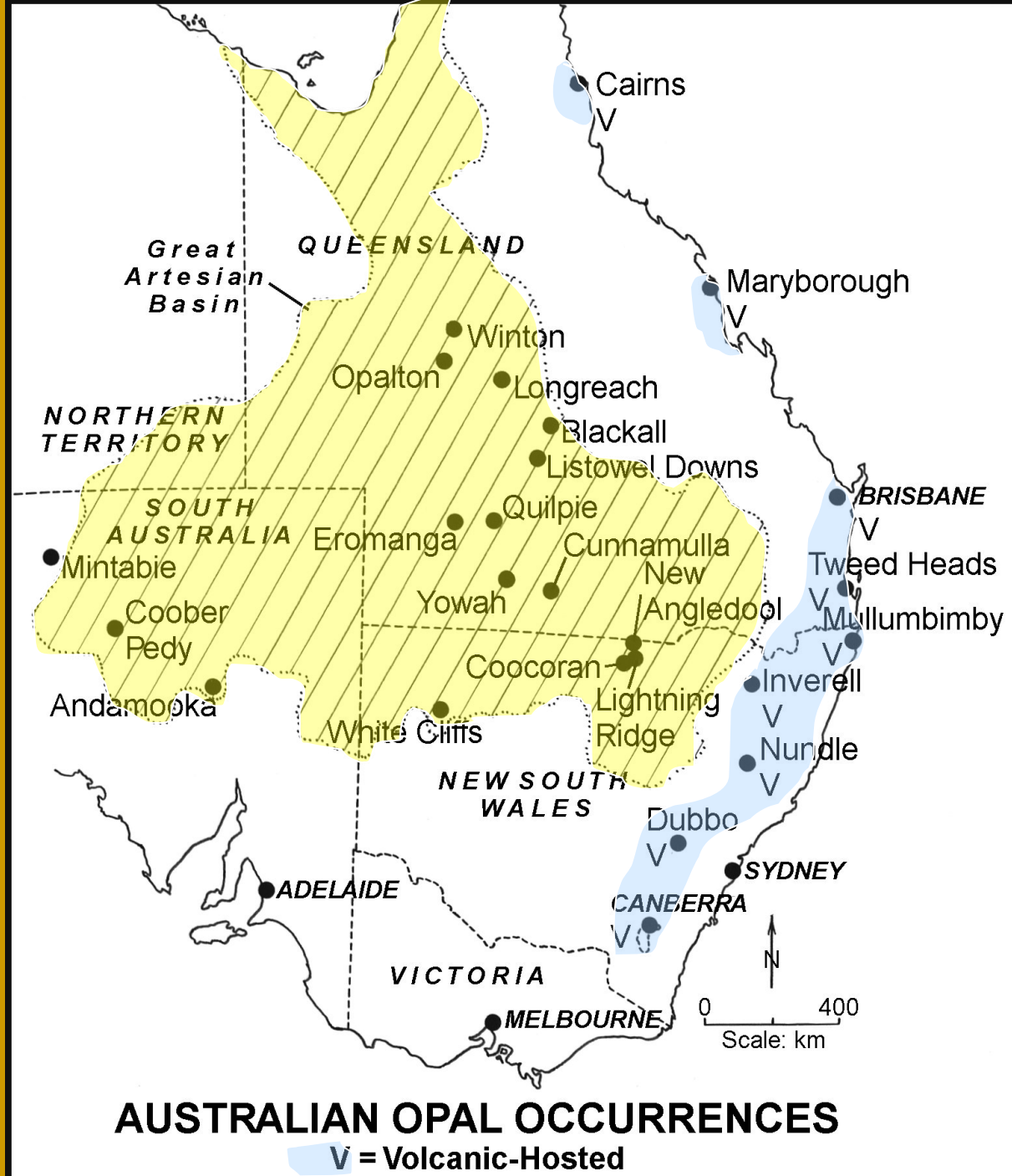


**Distinctive Luster**

**Lower Specific Gravity (1.9 to 2.25)**

# Australia Produces 95% of world's Precious Opal

(Only Australian  
state **not** known to  
host precious opal  
is Tasmania)



# Opal Classification

**Precious Opal** - Shows Play of Color  
(NOT called 'fire' as in other gemstones)

Play of Color = Spectrally pure individual colors

Combinations in patterns that shift in shape, hue, and dispersion as view angle & light source changes

Caused by diffraction of white light through micro-structure of orderly arranged silica spheres

**Potch** = Old Australian miner's term for valueless opal, even with minor play of color

Disordered silica spheres or cryptocrystalline

No color play except rare small point sources

**Common Opal** = No color play except rare small point sources

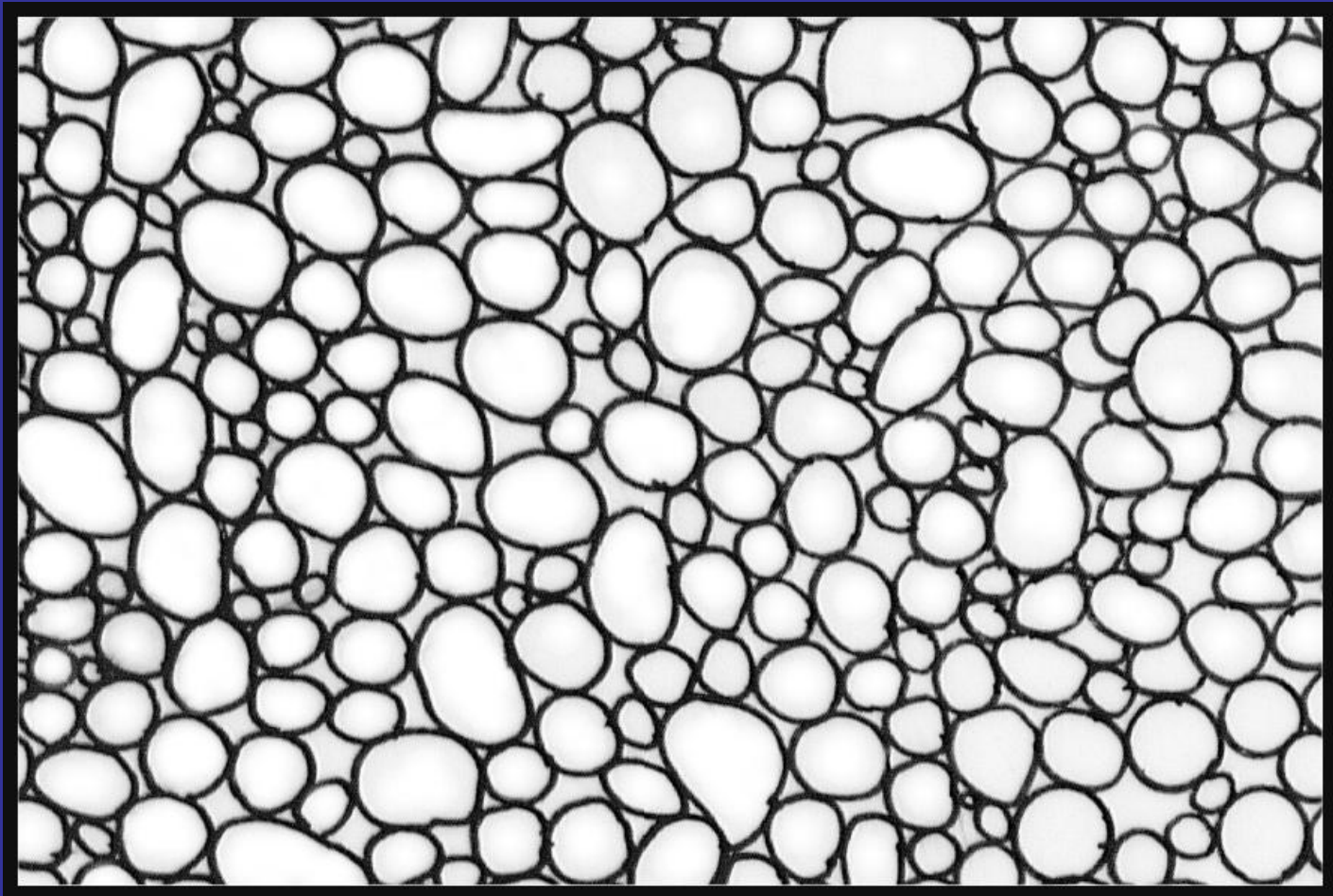
**Fire Opal** = Translucent to opaque yellow to orange

**Hyalite** = Clear, transparent



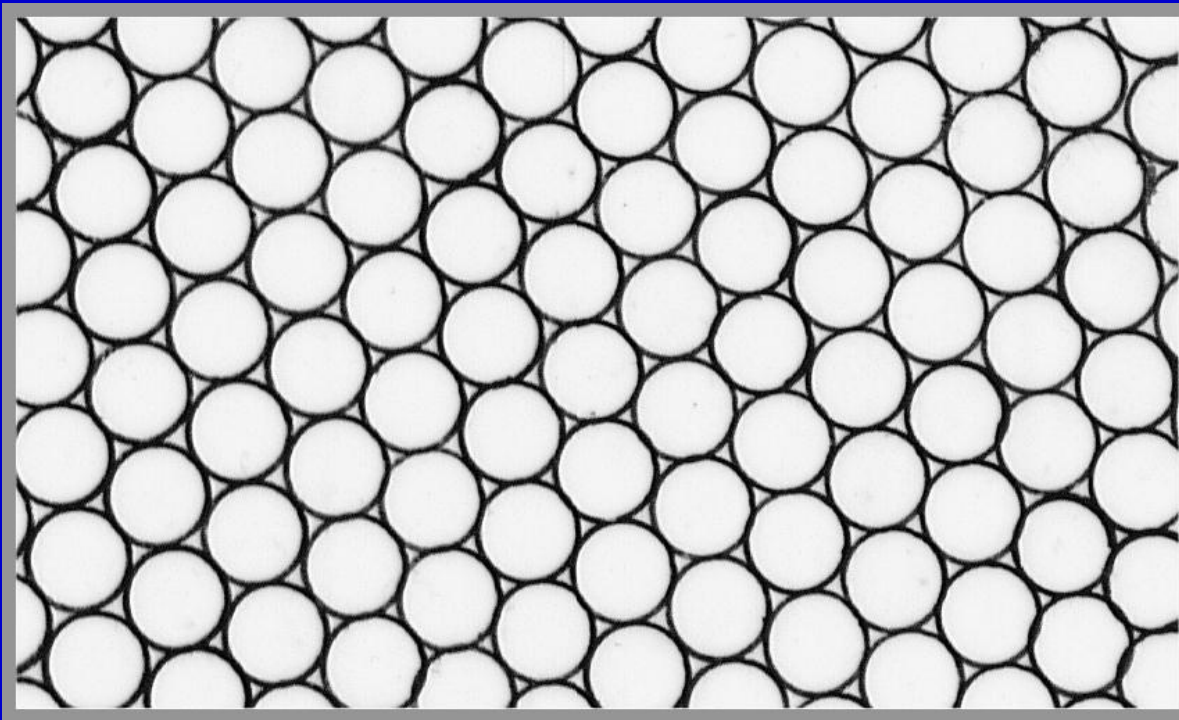
## Potch / Common Opal

Disordered, Irregular Shaped Silica Spheres  
Or Cryptocrystalline (No Spheres) Structure



Precious Opal - Areas of close-packed, aggregates of Uniform-sized amorphous silica spheres ~ 1500 Å -3500 Å diameter

(Darragh, Gaskin, and Sanders, 1976).



**Large Spheres**  
**Diffraction**  
**Red Light**  
**(Longer  $\lambda$ )**  
**Small Spheres**  
**Diffraction**  
**Blue Light**  
**(Shorter  $\lambda$ )**

**White light Diffraction through Micro-structured**  
**Orderly arranged silica spheres → Play of Color**

# Precious Opal

## Requires Stable Depositional Conditions

- $\text{H}_2\text{O}$  + Dissolved Silica
- Steadily Renewing Supply of Both  
Needed To

*Precipitate Multiple Layers*

*Uniform Silica Spheres*

**Rare Large Spheres (2500-3500 Å = Red)**

**Need Longer Stable Growth Time Than**

**Small (1500 - 2000 Å = Blue)**

**[10 million Å = 1 mm]**





# Blue Play of Color

Mintabie, Australia

# Thin Irregular Seams of Mintable Precious Opal within Common Opal



# ***Largest Precious Opal***

***Uncut Olympic Australis = 10.4 lbs***

Found at Coober Pedy in 1956

**Most Precious Opal Seams: 2 to 14 mm**

**Weight = Fraction Carat to ~ 4 ct**

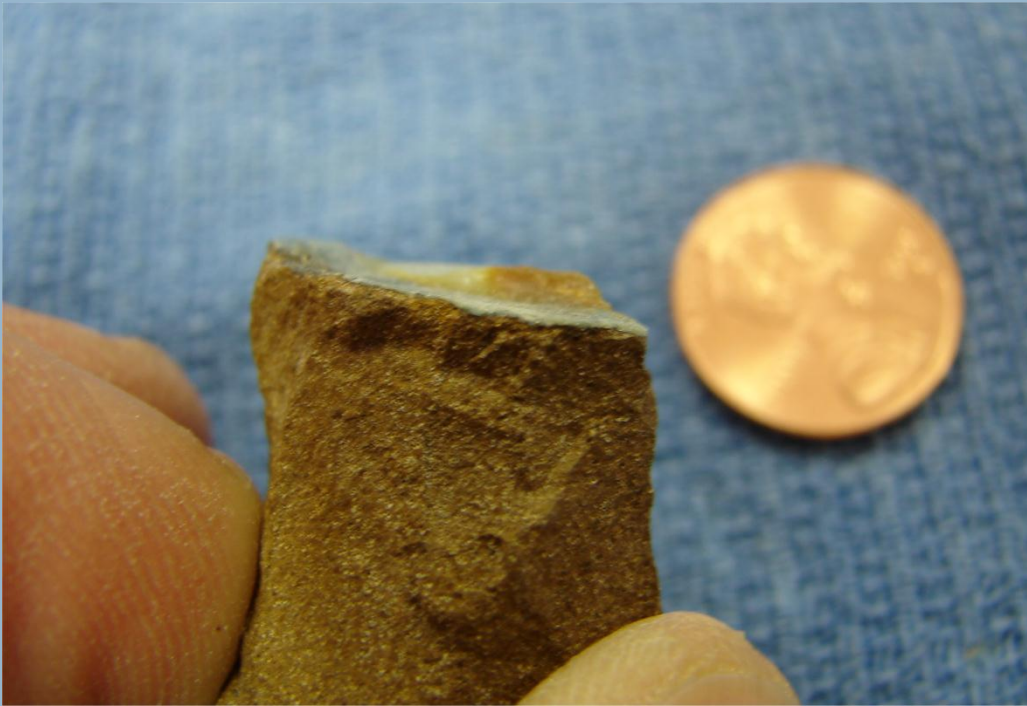
Queensland's Boulder Opal Generally:  
Thin Fracture Fillings of Fine Opal  
(Keller, 1990).

**Common Opal** = Tens of Feet Thick

**Weights = lbs to tons**



# **Thin Seam Lightning Ridge Opal**



# **Same Opal Seam Different View**



# Varieties & Marketing

- Boulder Opal*** – Sandstone or Ironstone Concretion broken by thin veins of precious or common opal
- *Marketed with part of the host rock attached*
  - Characteristic many Queensland deposits
  - *Was considered worthless potch before marketing*

- Matrix Opal*** - Infillings of holes or spaces (matrix) between grains of host rock in which it formed
- *Was considered worthless potch before marketing*

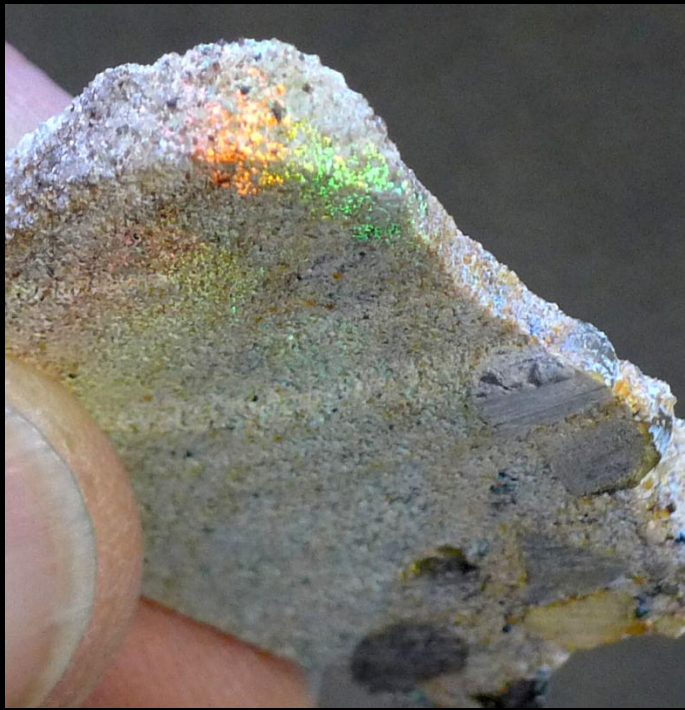


**Red, Green, &  
Blue Color Play**



**Lightning Ridge Boulder Opal**



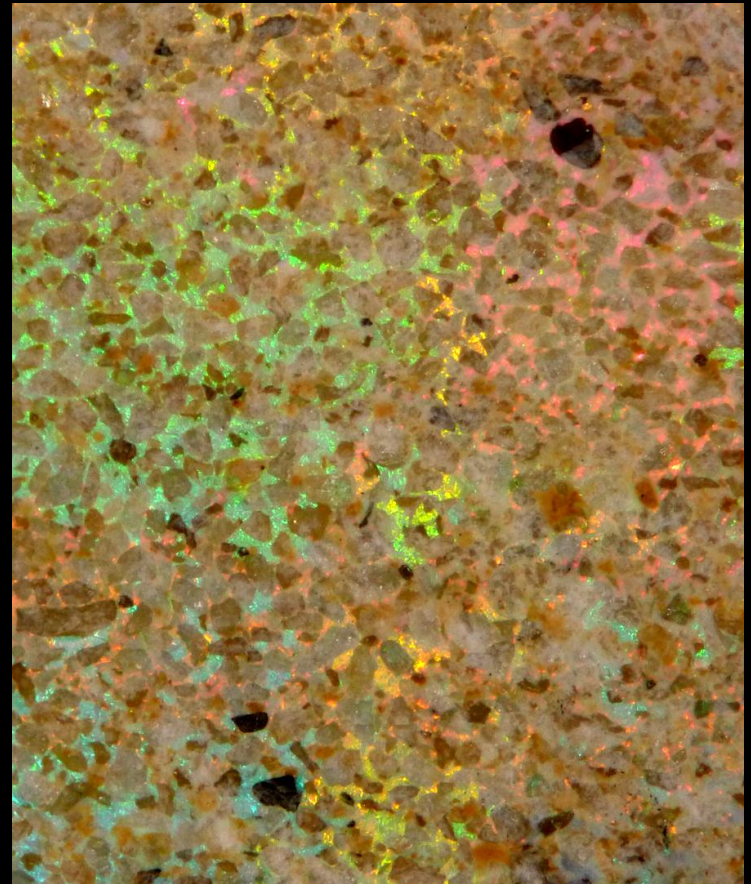


**Matrix Opal**  
**Miocene-Eocene (~12 to 40 Ma)**  
**Catahoula Fm**  
**Zones mms to cms Thick**  
**SE of Vicksburg, MS**

**Precious Opal Beneath**  
**Impermeable Si-rich Matrix**  
**& Quartz Sand**

**Hillside Above Flood-plain**

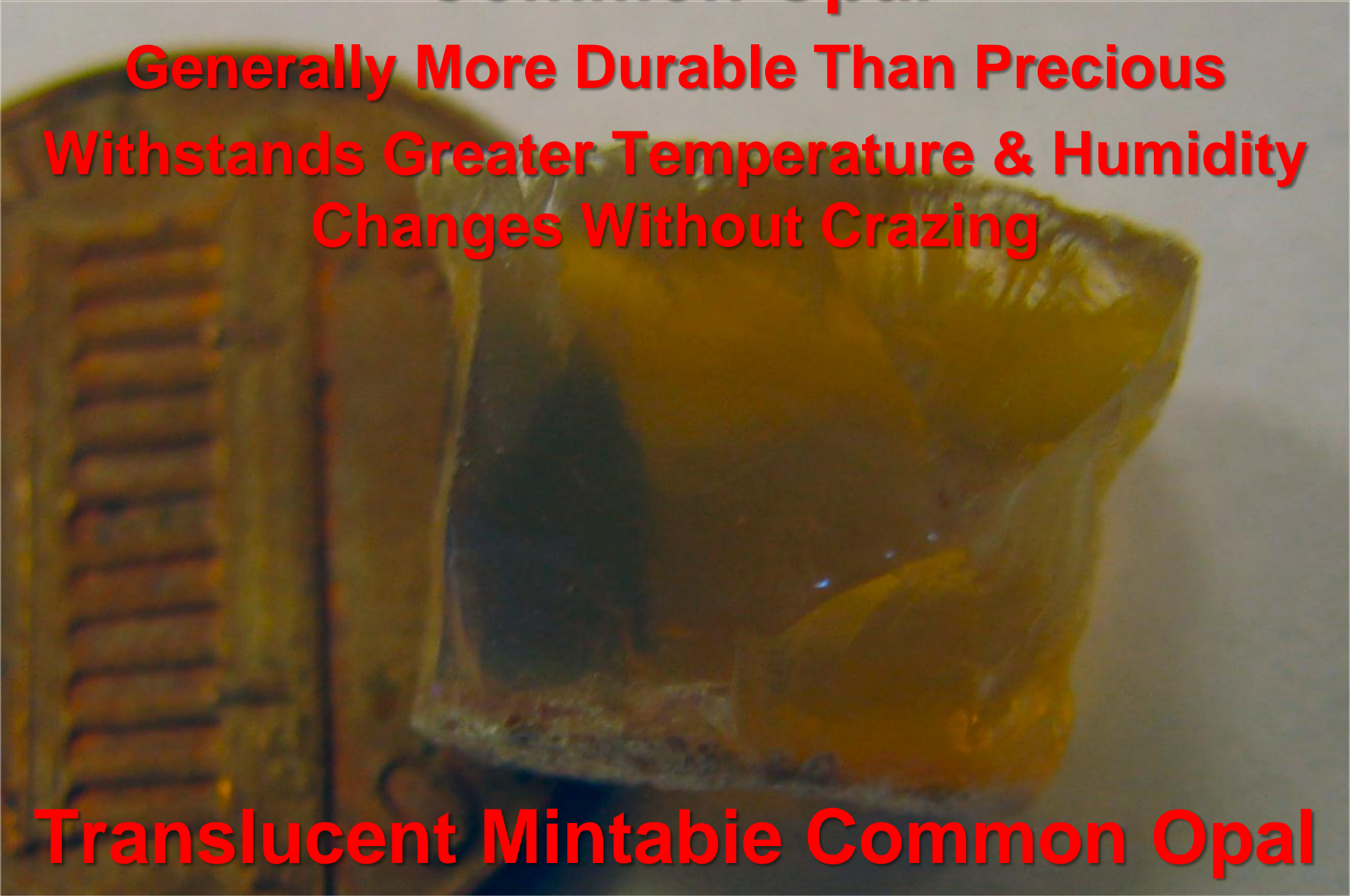
**D.F. Chandler, 2012**  
**(Personal Communication)**



# Common Opal

Generally More Durable Than Precious  
Withstands Greater Temperature & Humidity  
Changes Without Crazing

Translucent Mintabie Common Opal



# Age of Opal

**Precious Opal Geologically Young <100 Ma**

***Can't Survive Long Periods of Weathering***  
Dryness & Heat can Destroy

***Can't Survive Deep Burial*** & Accompanying  
Structural Adjustments - Heat & Pressure

**Deposition Rates: 1cm/5Ma to 1+mm/yr**

**Formation may be Ongoing in some areas**  
**(Partially Replaced Bones & Wood Fence Posts)**



# Australian Sediment-Hosted Opal

Base of deep weathering profile  
accompanied by intense bleaching

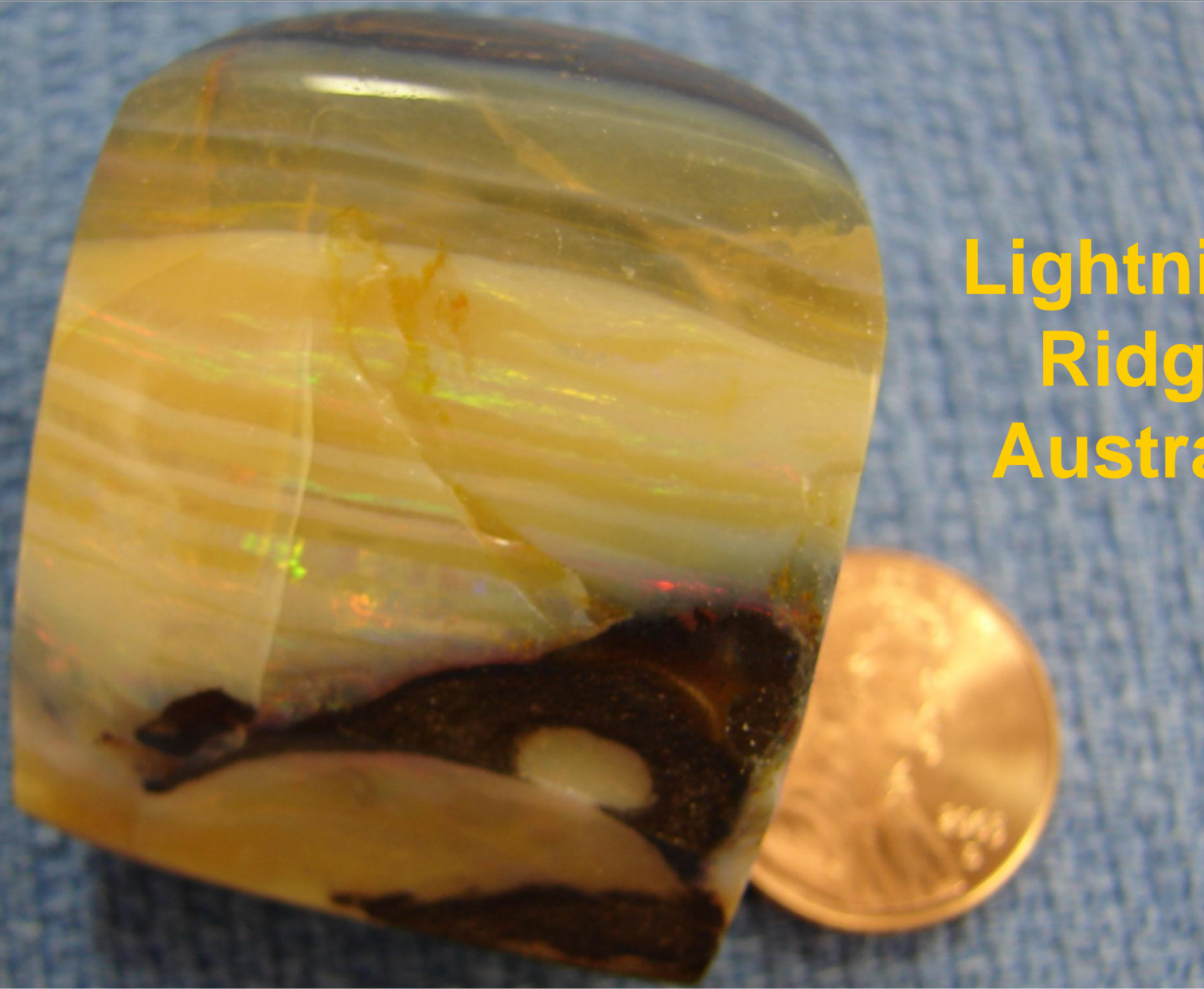
- \* Beneath silicified cap-rock or other thin silicified layers immediately above opal

Near-surface: 5m to 40m depth  
(steady-state depositional environment)

- \* Along contacts between porous kaolinized sandstone and underlying non-porous montmorillonitic claystone

May fill fractures & fault planes

# Sediment-Hosted Precious Opal



Lightning  
Ridge,  
Australia

# Australian Sediment-Hosted Opal Genetically Associated With Sulfates

- **Gypsum** ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) - Andamooka, SA
- **Gypsum & Alunite** ( $\text{KAl}_3(\text{SO}_4)_2(\text{OH})_6$ ) - Coober Pedy, SA
- **Gypsum and Glauberite** ( $\text{Na}_2\text{Ca}(\text{SO}_4)_2$ ) - White Cliffs, NSW
- **Alunite** - Lightning Ridge, NSW

**Discontinuous Gypsum Veins are found above many Australian opal deposits**

**Other Associations:** Kaolinite, Montmorillonite, Bentonite, Silicified Ironstone (concretionary iron)



# Many Different Silica Sources

All Directions of Si-rich H<sub>2</sub>O Movement Possible

- Volcanic ash beds (common in WY)
- Silicious micro-fossils
- Diagenesis of bentonites
- Kaolinization in situ of detrital feldspars
- Deep chemical weathering of pyroxenite (Arkansas), and serpentinite (Czech Republic and Slovakia)

# Volcanic-Hosted Opals: Two Types

**1 - Silica-Rich Meteoric Waters (weathering processes):** Similar to sediment-hosted deposits; show well-defined grain pattern  
(Darragh, Gaskin, and Sanders, 1976)

**2 - Post-Volcanic Hydrothermal Activity:**  
Generally transparent; no noticeable grain pattern; color play in diffuse bands

# Post-Volcanic Hydrothermal Opals

## Tiny Silica Spheres

(close packed arrays, few interstitial voids)

Contain More Water than sediment-hosted  
(less stable, greater tendency to craze; some exceptions in Mexican fire opals)

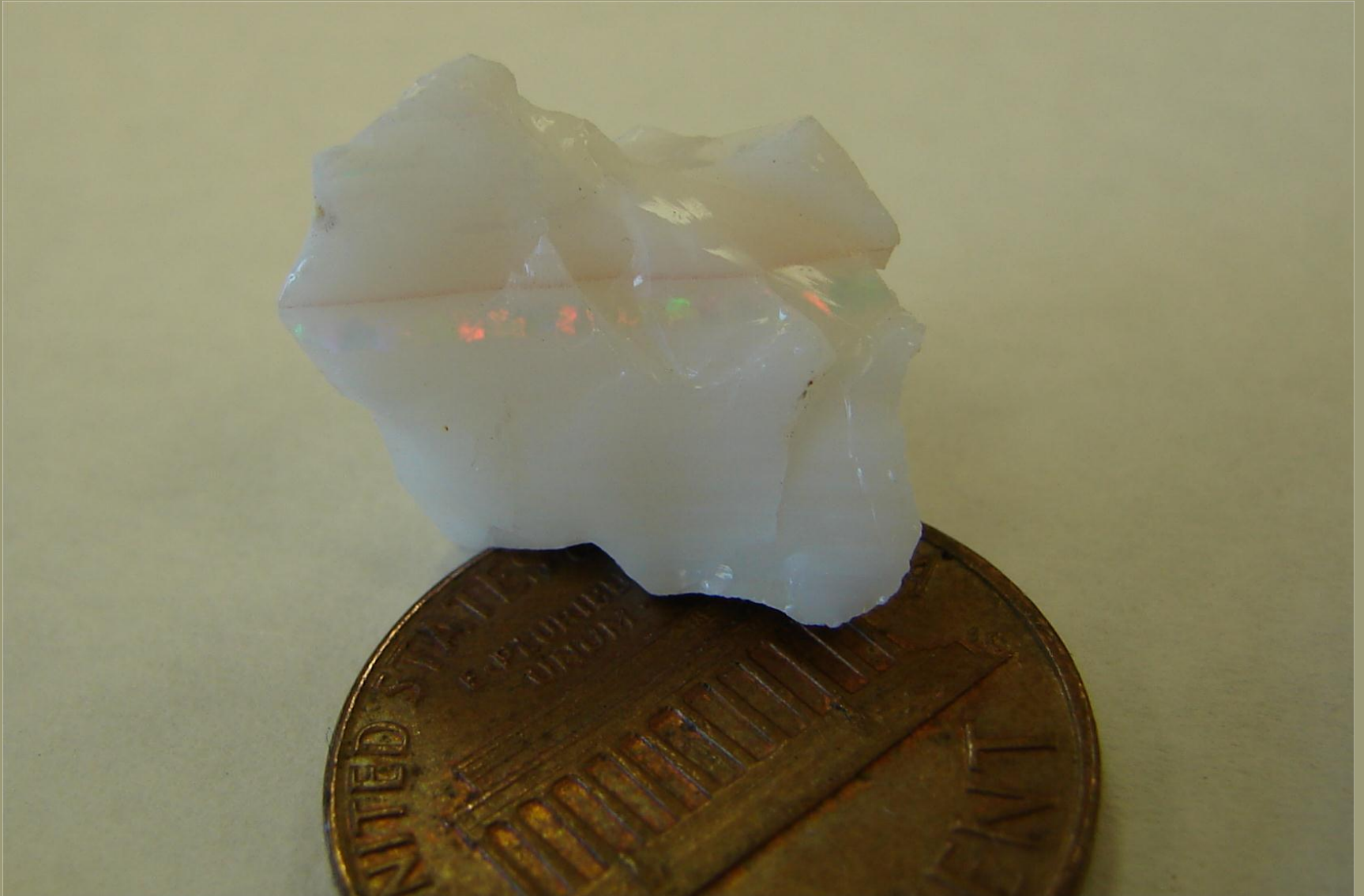
## Deposition Typically within Rounded Voids

(After gas bubbles)

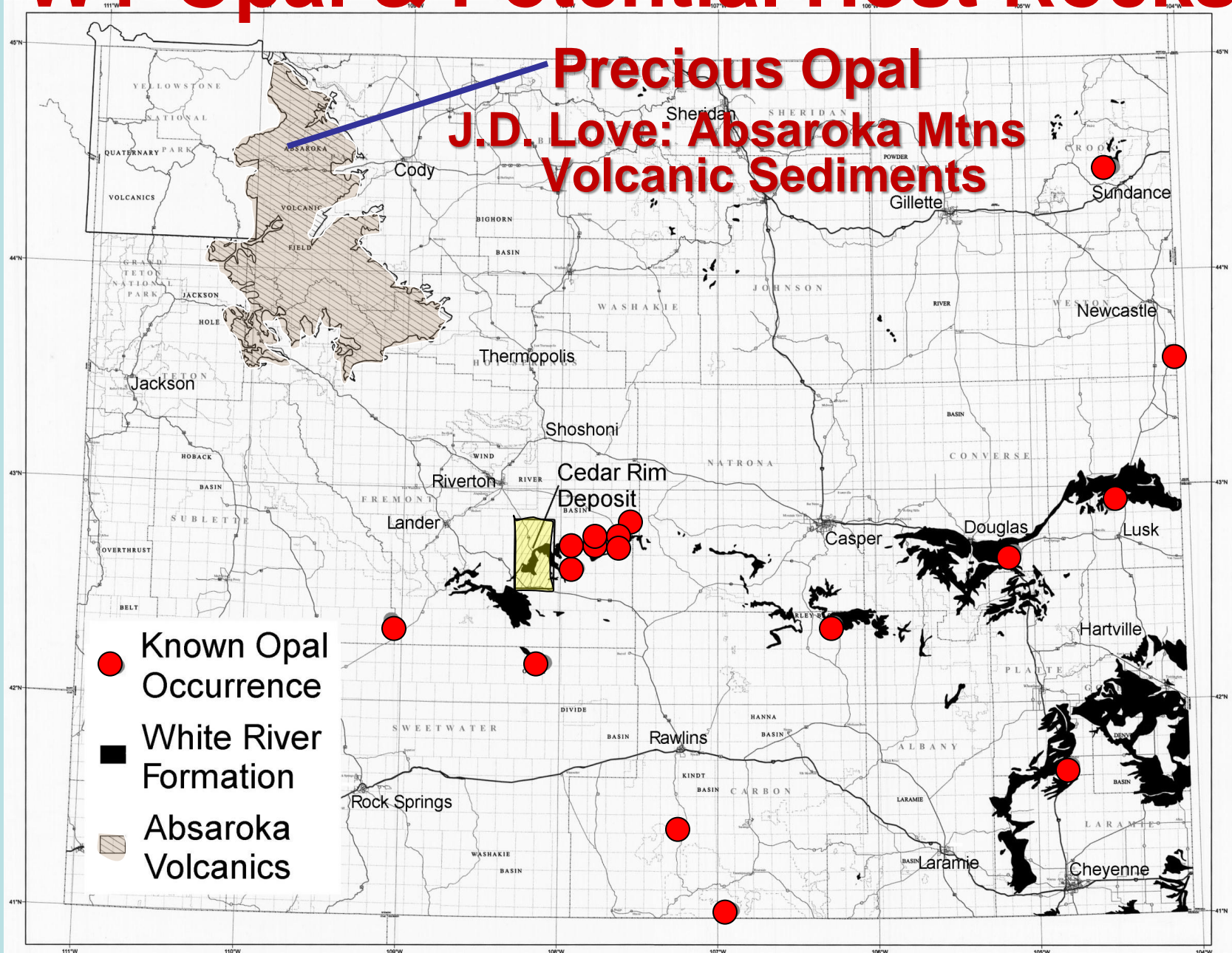
Deposited at higher than normal ground water temperatures



# Volcanic-Hosted Opal – Spencer, ID



# WY Opal & Potential Host Rocks



# Reported Host Rocks For Wyoming Opal

Quaternary **detrital materials**

Quaternary **geyser deposits**

Miocene-Pliocene **South Pass Fm**

Upper Miocene **Moonstone Fm**

Miocene **Browns Park Fm**

Miocene **Split Rock Fm**

Miocene **Arikaree Fm**

**Oligocene White River Fm** <sup>1</sup>

**Eocene Absaroka volcanic sediments** <sup>2</sup>

Eocene **Wagon Bed Fm**

Eocene **Wasatch Fm (Cathedral Bluffs Tongue)**

Eocene **Battle Springs Fm**

Eocene **Wind River Fm**

**Eocene Alkalic Igneous Rocks (Black Hills, Rattlesnake Hills)**

Lower **Cretaceous Fall River Fm**

Early **Proterozoic quartz monzonite (Hog Park)**

**Archean amphibolite schist (Tin Cup area)**

**Notes:** <sup>1</sup> Abundant common opal across WY; <sup>2</sup> Precious opal





**Thin Seam  
Opal  
Eocene  
Wagon Bed  
Fm  
Rattlesnake  
Hills**



- **Wind River Basin/Gas Hills** – Minor opal and uraniferous opal in **Wind River Fm**
- **Pathfinder Reservoir area** – Clear moss opal & common white opal in **Split Rock Fm**
- **Lost Creek-Cyclone Rim Area** – Common opal, gypsum, carbonates, and uranium in **Battle Spring Fm, Wasatch Fm, Quaternary alluvium** east of Lost Creek along Cyclone Rim fault zone
- **Miller Hill Area** 25 mi. S. of Rawlins – Opal, chalcedony, calcite, uranophane in **Miocene Browns Park Fm**
- **Southern Black Hills** – Opal, uranium in **Lower Cretaceous Fall River Fm**



# White River Formation Opal & Chalcedony SE of Chugwater





# Cedar Rim Opal

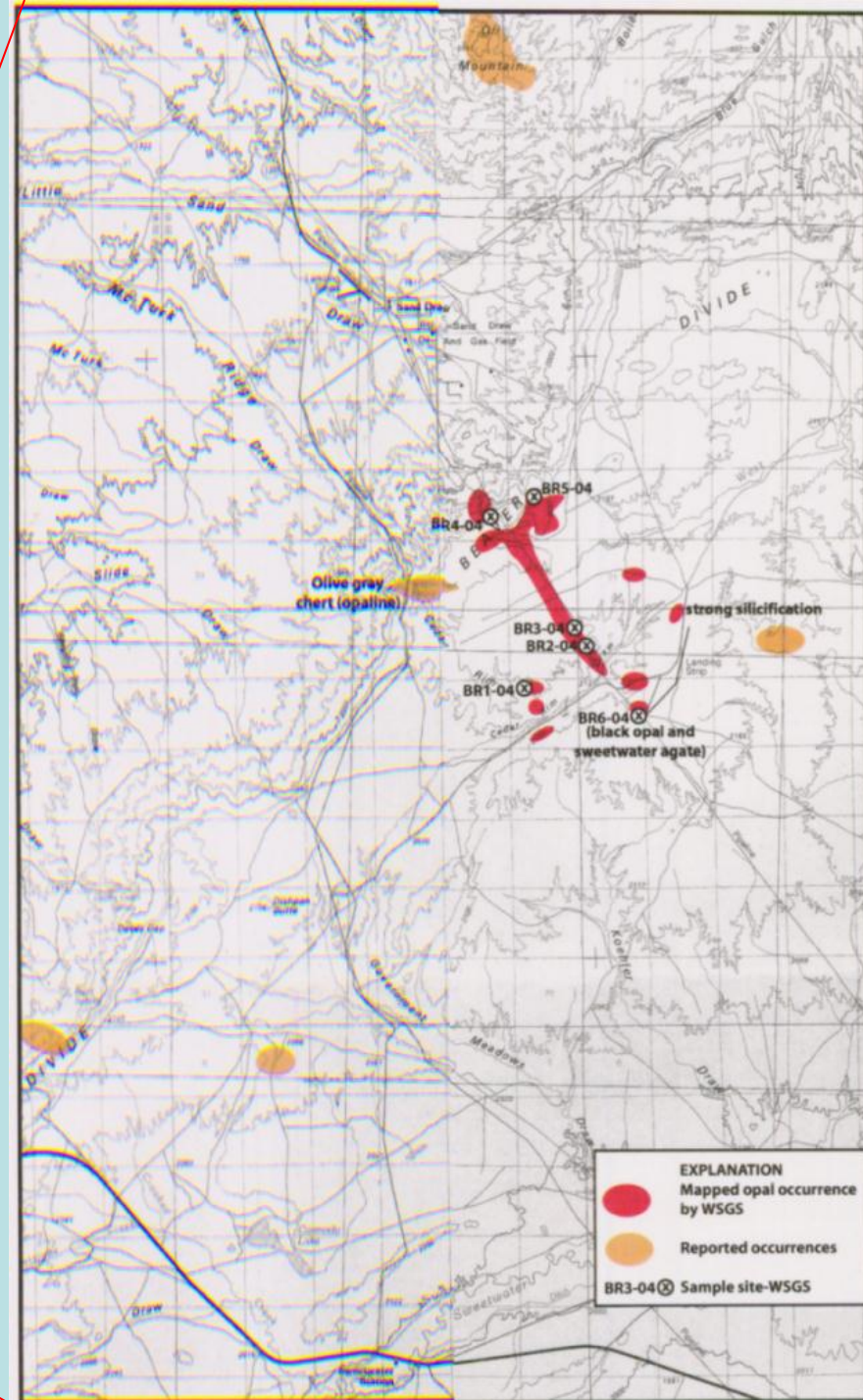
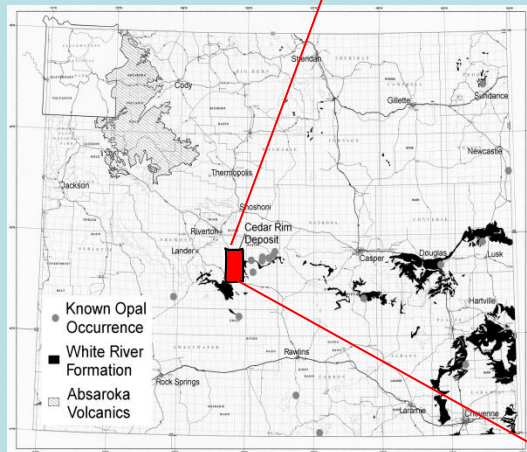
## White River Fm

Nodules in Altered Tuff:  
Replacements,  
Fracture & Void Fillings

Opal Cement in Arkose

## Wagon Bed Fm

## Split Rock Fm







# Opal Nodules In White River Fm. Cedar Rim Area, WY

**Depositional  
Environment  
Not Studied**

**Volcanic Ash  
Abundant in  
Tertiary  
Host-rocks**



# Common Opal – Wagon Bed Fm



**Opaque Green**

**Replacement Nodules**

**Breccia**





# Common Opal Cabochons

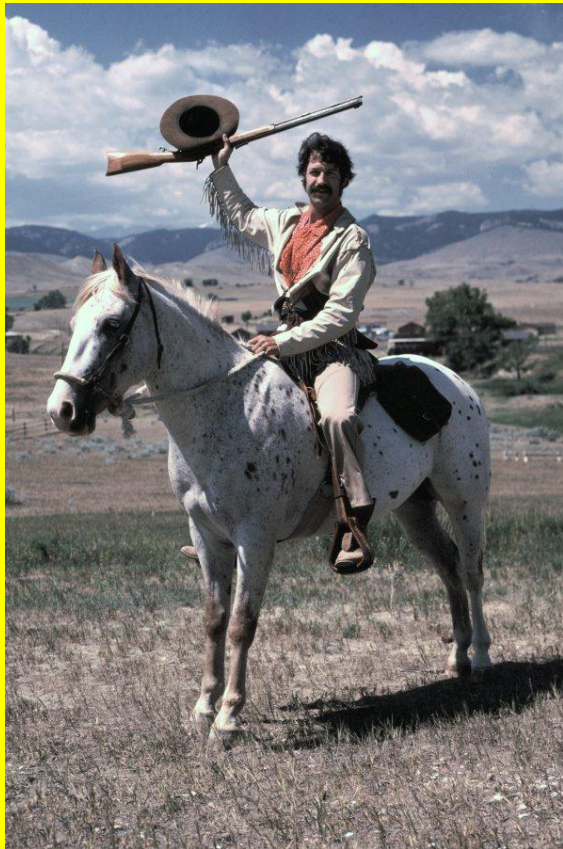
## Cedar Rim, WY



# Opal Exploration

## Sheepherders, Hunters, & Horsemen

*Are common denominators in  
Discovery of many Australian opal fields*



Low Specific Gravity &  
Brittleness prevent  
concentration in placers  
(*Except Residual Deposits  
at the source area*)

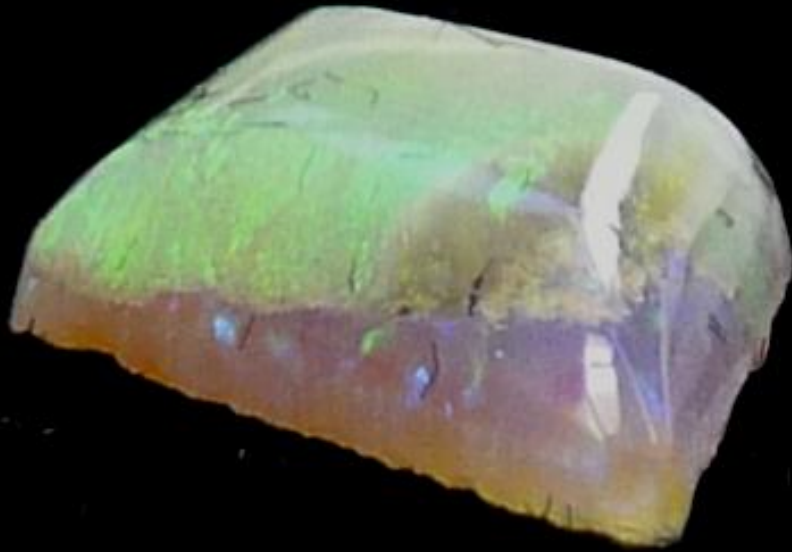


# **Sedimentary-Hosted Precious Opal Hunting Targets**

- **Silica-rich areas**
- **Bedding planes, fractures & faults**
- **Above impermeable or low permeability zones**
- **Below gypsum-rich or other salt zones**
- **Within or Below ironstone or siliceous concretionary materials**
- **Less than 40m below ground surface**



**LOOK FOR  
TINY OPAL  
SPHERES!**



**NOT LARGE  
SNOWBALLS!**